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# THE ISTHMIAN CANAL.

BY

ARTHUR P. DAVIS.

The unanimous judgment of the Isthmian Canal Commission, and the common consent of the general public, have very properly narrowed the discussion of the Isthmian Canal question down to a comparison of the relative merits of the two routes familiar as the Nicaragua and the Panama.

The thorough investigations and estimates of cost made by the Commission, and the recent offer of the Panama Canal Company to transfer their property to the United States for forty millions of dollars, make the total cost of the Nicaragua about \$190,000,000, and of the Panama \$184,000,000, not including the concessions which are yet to be obtained from the respective Governments. The work at Panama is so concentrated at the Bohio dam and the Culebra cut that its construction will require longer than the other route, and this will probably compensate for the difference in cost.

It may be assumed for the purposes of this comparison that the Panama Company can convey a perfect title, and that equally favourable concessions can be obtained from both Republics.

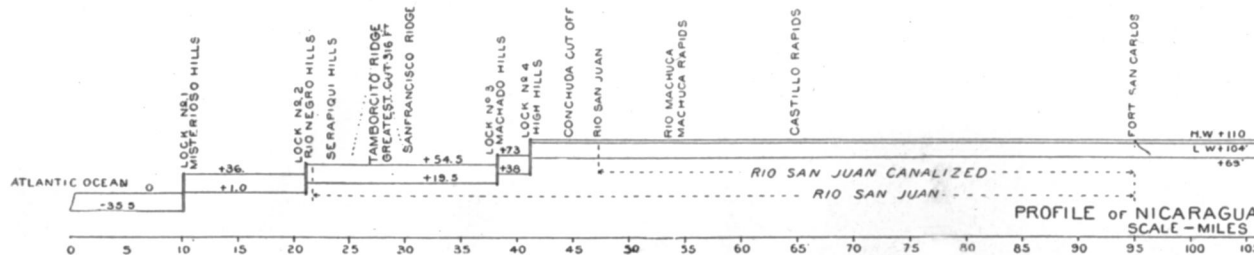
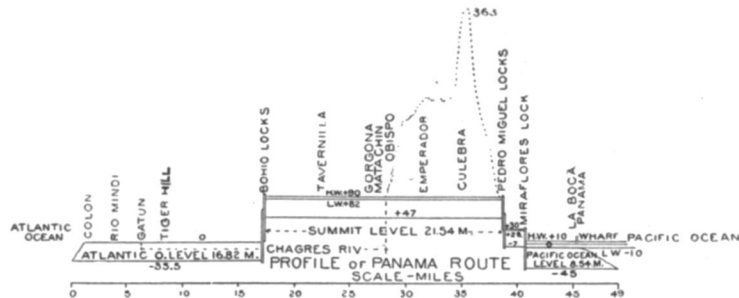
Many extravagant claims are made by the partisans of both routes, but their real important advantages may be summed up as follows:

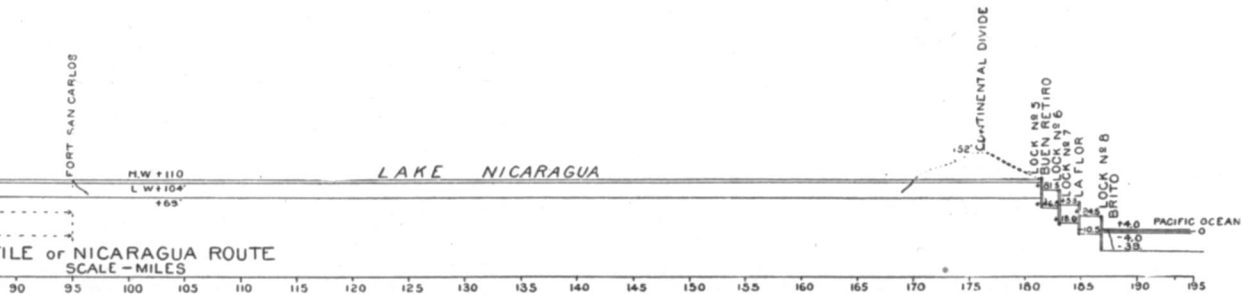
Advantages of Panama:

1. It is shorter, being 49 miles as against 184, and would for this and other reasons be cheaper to maintain and operate, and require less time for passage.
2. It has fewer curves, and they are of longer radius.
3. It has fewer locks.
4. It is shorter by several hundred miles from ports of western South America to all other points, the voyage to which would include the Isthmian Canal.

The advantages of the Nicaragua route are as follows:

1. It is several hundred miles shorter than the Panama route, on all voyages of which both termini are in the Northern Hemisphere—for instance, from San Francisco to New Orleans, New York or Liverpool, and from North American to Asiatic ports.
2. The constant trade winds afford better facilities for the approach and departure of sailing vessels than Panama can offer.





3. The canal route passes through an unsettled region of large extent and immense natural resources, which would be developed by the canal. This region will open up a large trade with American ports, and contribute a considerable revenue to the canal.

4. It is a healthier climate than Panama; though the reasons are not entirely clear, the fact is undeniable.

The above are the main real physical advantages that can be established by the respective routes; others claimed being mostly imaginary or relatively unimportant.

The advantages of Panama, and the first two assigned to Nicaragua, are purely material and reducible to a basis of dollars and cents, though the best judgments will differ as to actual figures. Nicaragua's advantages in health and development are of a totally different class, being much more difficult to estimate and to reduce to monetary expression. The first class of features will be first considered.

Where possible, in large engineering works, the usual and proper method of making estimates is by comparison with previous experience, allowing, as far as possible, for known differences of condition and circumstances. The probable cost of maintenance and operation of an American canal can best be estimated by this cost upon the great ship canals of the world, having due regard to difference of conditions.

The following table gives the traffic and cost of maintenance and operation of the four principal ship canals of the world, as taken from their official reports:

TRAFFIC AND COST OF OPERATION OF SHIP CANALS.

CANAL.	YEAR.	TRAFFIC IN TONS.	ANNUAL COST.
Manchester..... (35.5 miles.)	1898	2,595,585	\$861,976
	1899	2,778,108	927,140
	1900	3,060,516	1,004,333
Suez..... (88 miles.)	1898	9,238,603	1,592,834
	1899	9,895,630	1,661,042
	1900	9,738,152	1,742,717
Kiel..... (61.6 miles.)	1898	3,117,840	492,080
	1899	3,488,767	540,128
Sault Ste. Marie..... (1.6 miles.)	1897	17,619,933	78,104
	1898	18,622,754	58,890
	1899	21,958,347	90,307
	1900	22,315,834	79,293

The chief elements of cost in maintaining and operating a great canal depend upon its length, number of locks, amount of traffic,

and the amount and radius of its curvature. These may be compared in the following table:

COMPARISON OF SHIP CANALS.

	SAULT STE. MARIE.	SUEZ.	MANCHESTER.	KIEL.	PANAMA.	NICARAGUA.
Length in miles.....	1.6	88	35.05	61.6	49	184
In natural lakes.....	0	8	0	4	0	42
Bottom width in feet..	108	122	120	72	150	150
Depth in feet .....	21	28	26	29.5	35	35
Number of locks.....	1	0	5	2	5	9
Maximum lift in feet..	18	0	16.5	16	43	37
Total lift in feet.....	18	0	0	16	86	107
Radius, sharpest curve.	Infinite.	5900	1980	3280	6234	4045
Miles of curvature....	0	31	15.6	23	20	50
Degrees of curvature..	0	0	0	0	772	2340
Deepest cut in feet....	30	85	66	100	312	300
Cost—million dollars..	7.85	115	76	37	184	190
Traffic began.....	1855	1870	1894	1895	—	—

The most striking of the above facts is the great cost of operating the Manchester, considering its length and its traffic. This is accounted for by its large proportion of locks and its short radii of curvature. The latter feature is very important. When a large vessel is in a canal and draws nearly as much water as the available depth she will not obey her helm, and it becomes impossible to steer her safely around short curves, and a strong stern or beam wind aggravates the difficulty. For this reason every large vessel that passes through the Manchester Canal is attended by two tugs, one at bow and one astern, to conduct her along the tortuous channel. The Suez Canal was first built with curves of 2,300 feet radius; but these caused so much annoyance that a large part of the canal was reconstructed, and now the shortest radius is 5,900 feet, about three times that of Manchester. The great cost of maintenance and operation of the Manchester, and the low cost of that on the Kiel, together with the complication of length, locks, and curvature on both, make it difficult to use their data in estimating the relative influence of each feature on the total annual cost. In the Sault, however, we have a canal without curvature, only 1.6 miles long, and one lock. Its cost is, therefore, chiefly the maintenance and operation of that lock—about \$60,000 per annum—and is thus of value for comparison with the Isthmian Canal locks. Though it handles a very much heavier traffic than the Isthmian canal will ever have, the latter will have to contend with a wet tropical climate, and is remote from commercial centres,

and these will tend to increase its cost. We may, then, without important error, take \$60,000 per annum as the cost of maintaining and operating each lock on the Isthmus.

The Suez Canal has no locks, and very gentle curvature, and a traffic similar in character and magnitude to that expected for an Isthmian canal. It is, therefore, of value in estimating the annual cost due to length only. It is greatly annoyed by drifting sands, which increase its cost; but, on the other hand, the Panama Canal receives the waters of the Upper Chagres into Lake Bohio, which, though not a muddy stream, may in the future require some attention; while the Nicaragua route receives the waters of a large number of small tributaries, and Greytown harbour will require constant dredging to counteract the tendency to close up, under the littoral action on the sands; but these difficulties are not nearly so important as the drifting sands at Suez, and a much smaller figure should be taken for the American canals. From the above table we find the cost on Suez to average about \$19,000 per mile. Adopting \$15,000 for the mileage cost of the American canals, and \$60,000 each for the locks, we have figures which should approximately satisfy the conditions on the Isthmian canals. They give results somewhat too small when applied to Manchester, but larger than those reported for the Kiel.\*

In applying these estimates to the American canals, we will omit the deep water of Lake Nicaragua from the length of that canal, and we then obtain the following results:

For Nicaragua:

Length, 142 miles at \$15,000 per mile,	\$2,130,000
8 locks at \$60,000.....	480,000
Total annual cost.....	2,610,000

For Panama:

Length, 49 miles, at \$15,000 per mile,	735,000
5 locks at \$60,000.....	300,000
Total annual cost.....	1,035,000

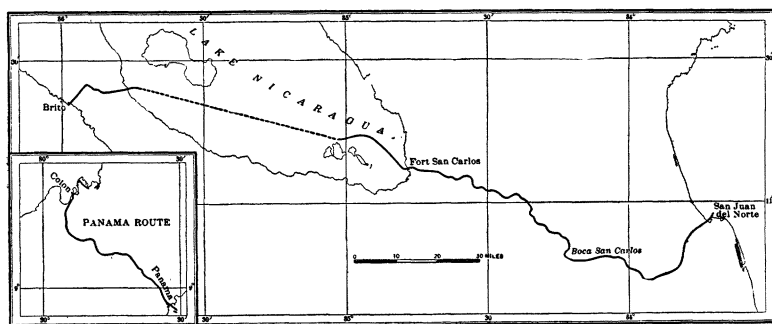
Assuming a traffic of 8,000,000 tons per annum, this would be nearly 33 cents per ton for Nicaragua, and 13 cents for Panama, without including any allowance for Panama's advantage in curva-

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\* The low cost reported for the Kiel canal is supposed to be due in part to that portion of its work performed by the Army and Navy, being charged to the military establishment instead of the canal.

ture, which the above table shows is considerable, nor for the fact that Panama will control her flood waters automatically, while Nicaragua will not.

It now remains to compare, in view of the above, their respective advantages in distance. A vessel cannot, with a given power, move so rapidly through a canal as through deep water, and if she could it would not be safe to do so. It may be assumed that, on an average, vessels will move through the canal at half the speed they would accomplish at sea. To allow for this we will, in comparing distances through the canals, add 40 nautical miles to those *via* Panama and 120 to those *via* Nicaragua, and this will compensate for their difference in length, since this is about the length in nautical miles in each case, which is equivalent to the assumed delay by the canal proper. By comparison of distances computed



on this basis we can determine their relative advantages to commerce.

It is estimated by good authorities that the average cost for carrying freight over long ocean voyages is one mill per ton-mile, of which one-half is for shore expenses, loading and unloading, warehouse, insurance, etc., leaving one-half mill per ton-mile for moving freight through the water.

There are eight typical routes of travel that would use an Isthmian canal. The following table shows the relative distances saved for these eight classes of traffic, allowing for delay in transit, due to canal length, as above indicated. The last column shows the amount per ton that vessels would save by going *via* Panama, on the assumption that both canals are to open traffic, and the tolls fixed to just cover cost of maintenance and operation, computed as above:



COMPARISON OF DISTANCES SAVED BY NICARAGUA AND PANAMA CANALS.

FROM	TO	VIA NICARAGUA.	VIA PANAMA.	SAVING VIA NICARAGUA.		NET ADVANTAGE OF PANAMA.
		MILES.	MILES.	MILES.	PER TON.	PER TON.
San Francisco	New York...	5,040	5,340	300	\$0.15	\$0.05
	Liverpool...	7,770	8,080	310	0.16	0.04
Yokohama	New Orleans..	4,240	4,740	500	0.25	-0.05
	New York...	10,870	11,050	180	0.09	0.11
	New Orleans..	10,070	10,450	380	0.19	0.01
Guayaquil, Ecuador,				SAVING VIA PANAMA.		
	New York...	3,370	2,910	460	0.23	0.43
	Liverpool...	6,100	5,650	450	0.22	0.42
	New Orleans..	2,560	2,300	260	0.13	0.33

From the above we observe that, on the assumed value of distance saved with the tolls adjusted to expenses, all steam traffic on seven of the typical routes would prefer the Panama Canal, the advantage of this route ranging from 1 to 43 cents per ton, while on the eighth type of voyage the advantage is with Nicaragua.

The above estimates apply only to traffic carried on in steam vessels. The Bay of Panama is so subject to protracted calms that it is not likely that sailing vessels will extensively use a canal at Panama; while the almost constant trade winds at Nicaragua will afford all desirable facility for approaching and leaving the canal and for passing through from east to west. It will not be easy, however, for sailing vessels to beat against the wind in a narrow, crooked channel, and east-bound sailing vessels will probably have to be towed through, which will be expensive. The advantage, however, is largely with Nicaragua as regards sailing vessels, which perform about 10 per cent. of the ocean freighting, while of the American Merchant Marine more than one-fourth is sail. These facts, taken with the showing above, indicate that perhaps one-third of the traffic would seek the Nicaragua route and two-thirds the Panama, if both were operated at cost. It is not surprising, therefore, that the latter was recommended by the Isthmian Canal Commission.

There are, however, two advantages possessed by Nicaragua, which should not be forgotten, and which largely offset the great advantage in annual cost which Panama will enjoy.

The Panama Canal crosses a narrow, mountainous isthmus, with little possibility of development, and with a very unhealthy climate.

On the other hand, the Nicaragua Canal will for most of its length pass through the heart of a vast tract of tropical forest, now a wilderness, with immense agricultural, horticultural, and mineral resources, capable of employing and supporting millions of people. A good harbour, interior transportation, and a stable government, which are now lacking, will be furnished by the construction of the canal. This great work will induce such an influx of American capital and immigration that they will soon dominate the country, and it will surely, like Hawaii, become American of its own motion. Its production of wealth will be enormous; the canal will furnish a fine outlet to all the world, with the aid, as feeders, of lakes Nicaragua and Managua, San Carlos, and Sarapiquí rivers, and numerous small streams.

The health of this region is remarkably good for a tropical country, yellow fever being unknown, though common both to the north and south; and other tropical ailments being less prevalent than elsewhere. The heat is not excessive, being greatly tempered by the fresh trade winds that prevail. If there is anywhere a tropical country susceptible of profitable Caucasian colonization it is the Nicaragua canal region.